ABN 58 855 816 942

The International Preliminary Examining Authority
Australian Patent Office
PO Box 200
Woden ACT 2606

4 January, 2005

Our Ref: 38098WOP00

Speed Dial: 508

CCN: 3710000352

Contact:
Russell Davies

Dear Sirs

Outokumpu Oyj
Patent Co-Operation Treaty Patent Application No. PCT/AU2004/000315
Title: AUXILIARY AGITATOR FOR A FLOTATION DEVICE

STATEMENT OF AMENDMENTS UNDER ARTICE 34

Complete Specification

Description

Cancel page 2 now on file and replace with new pages 2 and 2a.

Claims

Cancel pages 8-10 now on file and replace with new pages 8-11.

DATED this 4th day of January 2005
Outokumpu Oyj

by .....
RUSSELL DAVIES
Fellow Institute of Patent and Trade Mark Attorneys of Australia of Shelston IP

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[AMENDED PAGE]

As flotation devices increase in size, the agitation input energy must increase proportionally. Moreover, for a large flotation device to maintain efficiency, it must be capable of achieving a similar flotation kinetic rate as that achieved by a group of smaller cells of the same total volume.

In recent years, the size of flotation devices has increased, primarily for economic reasons. However, the design of such devices has remained relatively unchanged. Accordingly, for the reasons mentioned above, these large flotation devices are often not optimised in terms of flotation efficiency.

It is therefore an object of the present invention to overcome or substantially ameliorate one or more of the disadvantages of the prior art, or at least to provide a useful alternative.

SUMMARY OF THE INVENTION

Accordingly, a first aspect of the invention provides an auxiliary agitator for a flotation device of the type having a tank, a primary agitator including a primary rotor, drive means, and a drive shaft disposed intermediate the drive means and the primary rotor, the auxiliary agitator including:

an auxiliary agitation blade adapted, in use, to induce axial fluid flow in a downward direction so as to supplement flow induced in the tank by the primary rotor; and

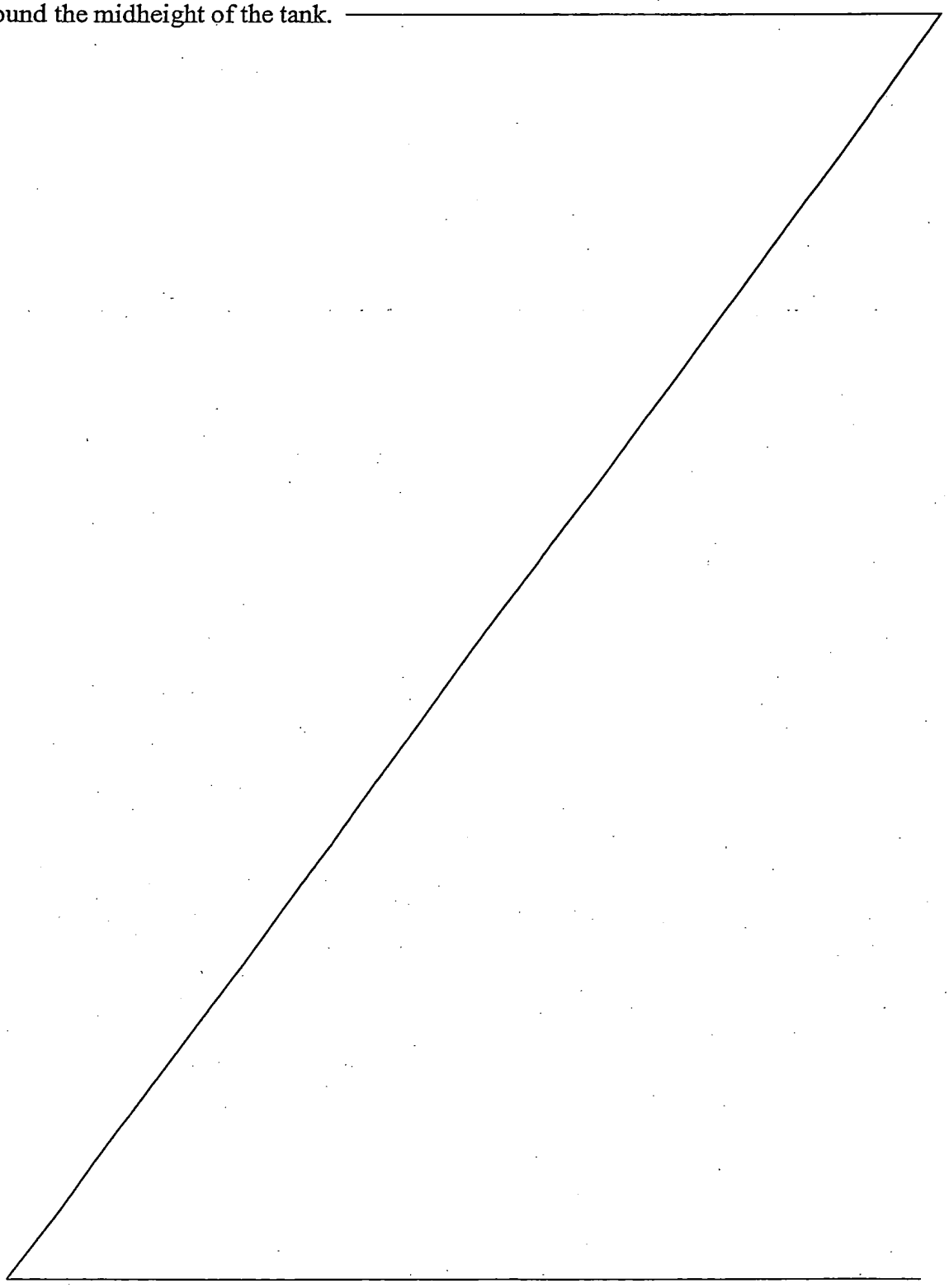
connecting means for connecting the auxiliary agitation blade to the drive shaft intermediate the drive means and the primary rotor, for conjoined rotation with the primary rotor.

Preferably, the angle of incidence is constant along the length of the blade, as in an axial impeller, at between 15 degrees and around 75 degrees with respect to the direction of travel of the blade. Alternatively, the angle of incidence varies along the length of the blade, as in a propeller. In another embodiment, the pitch of the blade is adjustable depending on specific system parameters, such as slurry density, slurry viscosity or flow characteristics within the tank.

Preferably, the blade includes a substantially straight leading edge. However, in alternative embodiments, the leading edge may be curved.

[AMENDED PAGE]

Preferably, the blade is releasably connected to the shaft to allow its position along the shaft to be adjusted. However, the blade is preferably connected to the shaft at around the midheight of the tank.



CLAIMS

1. [AMENDED] An auxiliary agitator for a flotation device of the type having a tank, a primary agitator including a primary rotor, drive means, and a drive shaft disposed intermediate the drive means and the primary rotor, the auxiliary agitator including:

an auxiliary agitation blade adapted, in use, to induce axial fluid flow in a downward direction so as to supplement flow induced in the tank by the primary rotor; and

connecting means for connecting the auxiliary agitation blade to the drive shaft intermediate the drive means and the primary rotor, for conjoined rotation with the primary rotor.

2. An agitator according to claim 1, wherein the auxiliary agitation blade defines an angle of incidence that is substantially constant along the length of the blade, as in an axial impeller.

3. An agitator according to claim 2, wherein the angle of incidence is between 15 degrees and around 75 degrees with respect to the direction of travel of the blade.

4. An agitator according to claim 1, wherein the auxiliary agitation blade defines an angle of incidence that varies along the length of the blade, as in a propeller.

5. An agitator according to claim 1, wherein the pitch of the blade is adjustable depending on specific system parameters, such as slurry density, slurry viscosity or flow characteristics within the tank.

6. An agitator according to any one of the preceding claims, wherein the blade includes a substantially straight leading edge.

7. An agitator according to any one of claims 1 to 5, wherein the leading edge of the blade is curved.

8. An agitator according to any one of the preceding claims, wherein the blade is releasably connected to the shaft to allow its position relative to the primary rotor to be adjusted.

9. An agitator according to any one of the preceding claims, wherein, in use, the blade is connected to the shaft at around a midheight of the tank.

10. An agitator according to any one of the preceding claims, wherein the connecting means include a clamp.

11. An agitator according to claim 10, wherein the clamp is formed of two inter-engageable clamping halves.

12. An agitator according to claim 11, wherein the two clamping halves are substantially identical.

13. An agitator according to any one of claims 10 to 12, wherein inner walls of the clamp together define a generally cylindrical clamping surface.

14. An agitator according to any one of claims 1 to 9, wherein the connecting means take the form of welds or bolts.

15. An agitator according to any one of the preceding claims, including a resilient protective layer coating its exterior surfaces.

16. An agitator according to claim 15, wherein the protective layer is greater than around 3mm thick.

17. An agitator according to claim 14 or claim 15, wherein the protective layer is between around 5mm and around 7mm thick.

18. An agitator according to any one of the preceding claims, including a pair of the auxiliary blades, in use extending radially outwardly from diametrically opposite sides of the shaft, each blade having associated connecting means.

19. An agitator according to any one of claims 1 to 18, including at least three of the blades, in use equally spaced around the perimeter of the shaft, each blade having associated connecting means.

20. An agitator according to claim 18 or claim 19, wherein, in use, each blade intersects the shaft at an angle of incidence of around 45 degrees.

21. Agitation means for a flotation device of the type having a tank, a primary agitator including a primary rotor, drive means, and a drive shaft disposed intermediate the drive means and the primary rotor, said agitation means including:

a drive shaft;

a primary rotor connected to one end of the drive shaft to form the primary agitator; and

an auxiliary agitator as defined in any one of claims 1 to 20.

22. Agitation means according to claim 21, wherein the auxiliary agitation blade is releasably connected to the shaft to allow its position relative to the primary rotor to be adjusted.

23. Agitation means according to claim 21 or claim 22, being adapted for use in a three phase environment including water, solids and air.

24. A flotation device including:

a tank for containing slurry incorporating minerals to be extracted;

a feed inlet for admission of slurry into the tank;

agitation means, as defined in any one of claims 21 to 23, to agitate the slurry within the tank; and

aeration means to aerate the slurry whereby floatable minerals in suspension form a surface froth.

25. A flotation device according to claim 24, including a stator surrounding the rotor.

26. A flotation device according to claim 24 or claim 25, including a peripheral overflow launder extending around the inside top of the tank for recovering mineral enriched froth from the surface.

27. A flotation device according to any one of claims 24 to 26, wherein the aeration means include an air blower and a fluid conduit for directing air from the blower into the rotor.

28. A flotation device according to claim 27, wherein the conduit includes an axial bore extending through the drive shaft.

29. A flotation device according to claim 27 or claim 28, wherein the conduit is disposed to direct air into the rotor from underneath.

30. A flotation device according to any one of claims 24 to 29, including a froth deflection cone extending around the drive shaft adjacent the top of the tank, the smallest diameter of the cone being at its lowermost end nearest the rotor.

31. A flotation device according to claim 30, wherein the deflection cone is disposed to deflect froth outwardly toward the overflow launder as it migrates toward the surface of the tank.

32. A flotation device according to claim 30 or claim 31, wherein the deflection cone is disposed to prevent vortexing at the tank surface.

34. A flotation device according to any one of claims 30 to 32, wherein the auxiliary agitator is located substantially midway between the top of the rotor and the bottom of the deflection cone.

35. A flotation device according to any one of claims 30 to 34, including a reagent addition tube extending downwardly into the tank through the deflection cone.

36. An auxiliary agitator as defined in any one of the preceding claims, adapted for agitating a slurry containing up to around 55% solids.

37. An auxiliary agitator as defined in any one of the preceding claims, adapted for use in a flotation device having a tank with a capacity of at least $50m^3$.

38. An auxiliary agitator as defined in any one of the preceding claims, wherein the auxiliary agitation blade, in use, acts as an axial impeller to supplement an axial flow induced in the tank by the primary rotor.

39. An auxiliary agitator as defined in claim 37, wherein said axial impeller has a diameter of around 15% to around 35% of the tank diameter.

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14 April, 2005

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Contact: Stuart Smith

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Title: AUXILIARY AGITATOR FOR A FLOTATION DEVICE

STATEMENT OF AMENDMENTS

Complete Specification

Description

3. Cancel page 2 now on file and replace with new page 2

Claims

4. Cancel pages 8 to 11 now on file and replace with new pages 8 to 11

DATED this 14th day of April 2005
Outokumpu Oyj

by .....
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Fellow Institute of Patent and Trade Mark Attorneys of Australia of Shelston IP

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In recent years, the size of flotation devices has increased, primarily for economic reasons. However, the design of such devices has remained relatively unchanged. Accordingly, for the reasons mentioned above, these large flotation devices are often not optimised in terms of flotation efficiency.

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SUMMARY OF THE INVENTION

Accordingly, a first aspect of the invention provides an auxiliary agitator for a flotation device of the type having a tank, a primary agitator including a primary rotor adapted to induce radial fluid flow, drive means, and a drive shaft disposed intermediate the drive means and the primary rotor, the auxiliary agitator including:

an auxiliary agitation blade disposed above the primary rotor and adapted, in use, to induce axial fluid flow in a downward direction so as to supplement flow induced in the tank by the primary rotor; and

connecting means for connecting the auxiliary agitation blade to the drive shaft for conjoined rotation with the primary rotor.

Preferably, the angle of incidence is constant along the length of the blade, as in an axial impeller, at between 15 degrees and around 75 degrees with respect to the direction of travel of the blade. Alternatively, the angle of incidence varies along the length of the blade, as in a propeller. In another embodiment, the pitch of the blade is adjustable depending on specific system parameters, such as slurry density, slurry viscosity or flow characteristics within the tank.

Preferably, the blade includes a substantially straight leading edge. However, in alternative embodiments, the leading edge may be curved.

CLAIMS

1. An auxiliary agitator for a flotation device of the type having a tank, a primary agitator including a primary rotor adapted to induce radial fluid flow, drive means, and a drive shaft disposed intermediate the drive means and the primary rotor, the auxiliary agitator including:

an auxiliary agitation blade disposed above the primary rotor and adapted, in use, to induce axial fluid flow in a downward direction so as to supplement flow induced in the tank by the primary rotor; and

connecting means for connecting the auxiliary agitation blade to the drive shaft for conjoined rotation with the primary rotor.

2. An agitator according to claim 1, wherein the auxiliary agitation blade defines an angle of incidence that is substantially constant along the length of the blade, as in an axial impeller.

3. An agitator according to claim 2, wherein the angle of incidence is between 15 degrees and around 75 degrees with respect to the direction of travel of the blade.

4. An agitator according to claim 1, wherein the auxiliary agitation blade defines an angle of incidence that varies along the length of the blade, as in a propeller.

5. An agitator according to claim 1, wherein the pitch of the blade is adjustable depending on specific system parameters, such as slurry density, slurry viscosity or flow characteristics within the tank.

6. An agitator according to any one of the preceding claims, wherein the blade includes a substantially straight leading edge.

7. An agitator according to any one of claims 1 to 5, wherein the leading edge of the blade is curved.

8. An agitator according to any one of the preceding claims, wherein the blade is releasably connected to the shaft to allow its position relative to the primary rotor to be adjusted.

9. An agitator according to any one of the preceding claims, wherein, in use, the blade is connected to the shaft at around a midheight of the tank.

10. An agitator according to any one of the preceding claims, wherein the connecting means include a clamp.

11. An agitator according to claim 10, wherein the clamp is formed of two inter-engageable clamping halves.

12. An agitator according to claim 11, wherein the two clamping halves are substantially identical.

13. An agitator according to any one of claims 10 to 12, wherein inner walls of the clamp together define a generally cylindrical clamping surface.

14. An agitator according to any one of claims 1 to 9, wherein the connecting means take the form of welds or bolts.

15. An agitator according to any one of the preceding claims, including a resilient protective layer coating its exterior surfaces.

16. An agitator according to claim 15, wherein the protective layer is greater than around 3mm thick.

17. An agitator according to claim 14 or claim 15, wherein the protective layer is between around 5mm and around 7mm thick.

18. An agitator according to any one of the preceding claims, including a pair of the auxiliary blades, in use extending radially outwardly from diametrically opposite sides of the shaft, each blade having associated connecting means.

19. An agitator according to any one of claims 1 to 18, including at least three of the blades, in use equally spaced around the perimeter of the shaft, each blade having associated connecting means.

20. An agitator according to claim 18 or claim 19, wherein, in use, each blade intersects the shaft at an angle of incidence of around 45 degrees.

21. Agitation means for a flotation device of the type having a tank, a primary agitator including a primary rotor, drive means, and a drive shaft disposed intermediate the drive means and the primary rotor, said agitation means including:

a drive shaft;

a primary rotor adapted to induce radial fluid flow and connected to one end of the drive shaft to form the primary agitator; and

an auxiliary agitator as defined in any one of claims 1 to 20.

22. Agitation means according to claim 21, wherein the auxiliary agitation blade is releasably connected to the shaft to allow its position relative to the primary rotor to be adjusted.

23. Agitation means according to claim 21 or claim 22, being adapted for use in a three phase environment including water, solids and air.

24. A flotation device including:

a tank for containing slurry incorporating minerals to be extracted;

a feed inlet for admission of slurry into the tank;

agitation means, as defined in any one of claims 21 to 23, to agitate the slurry within the tank; and

aeration means to aerate the slurry whereby floatable minerals in suspension form a surface froth.

25. A flotation device according to claim 24, including a stator surrounding the rotor.

26. A flotation device according to claim 24 or claim 25, including a peripheral overflow launder extending around the inside top of the tank for recovering mineral enriched froth from the surface.

27. A flotation device according to any one of claims 24 to 26, wherein the aeration means include an air blower and a fluid conduit for directing air from the blower into the rotor.

28. A flotation device according to claim 27, wherein the conduit includes an axial bore extending through the drive shaft.

29. A flotation device according to claim 27 or claim 28, wherein the conduit is disposed to direct air into the rotor from underneath.

30. A flotation device according to any one of claims 24 to 29, including a froth deflection cone extending around the drive shaft adjacent the top of the tank, the smallest diameter of the cone being at its lowermost end nearest the rotor.

31. A flotation device according to claim 30, wherein the deflection cone is disposed to deflect froth outwardly toward the overflow launder as it migrates toward the surface of the tank.

32. A flotation device according to claim 30 or claim 31, wherein the deflection cone is disposed to prevent vortexing at the tank surface.

34. A flotation device according to any one of claims 30 to 32, wherein the auxiliary agitator is located substantially midway between the top of the rotor and the bottom of the deflection cone.

35. A flotation device according to any one of claims 30 to 34, including a reagent addition tube extending downwardly into the tank through the deflection cone.

36. An auxiliary agitator as defined in any one of the preceding claims, adapted for agitating a slurry containing up to around 55% solids.

37. An auxiliary agitator as defined in any one of the preceding claims, adapted for use in a flotation device having a tank with a capacity of at least $50m^3$.

38. An auxiliary agitator as defined in any one of the preceding claims, wherein the auxiliary agitation blade, in use, acts as an axial impeller to supplement an axial flow induced in the tank by the primary rotor.

39. An auxiliary agitator as defined in claim 37, wherein said axial impeller has a diameter of around 15% to around 35% of the tank diameter.

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JC20 Rec'd PCT/PTO 16 SEP 2005

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Contact:
Russell Davies

Dear Commissioner

Outokumpu Oyj
Patent Co-Operation Treaty Patent Application No. PCT/AU2004/000315
Title: AUXILIARY AGITATOR FOR A FLOTATION DEVICE

We refer to the Written Opinion of the International Searching Authority, the date of mailing of which was 2 April 2004, in relation to this application.

We now **enclose** a request for International Preliminary Examination of the application. In response to the issues raised in the Written Opinion, we also **lodge** herewith a Statement of Amendments under Article 34, together with a marked-up copy indicating the nature and location of those amendments. In addition, we make the following observations in relation to the cited prior art, in the context of the amended claims.

Citation D1 (US 6,109,449 to Howk et al) discloses a flotation cell including a tank 10 and agitation means in the form of a primary axial flow impeller 26 connected to a drive mechanism 40 by means of a drive shaft 32. The axial impeller 26 is adapted to direct fluid in a central region of the tank downwardly toward the bottom of the tank, thence radially outwardly and upwardly along the outer side wall, in a generally annular circulation path. A secondary radial flow impeller 24, of smaller diameter, is mounted at an intermediate location on the shaft 32, above the primary impeller 26. The radial impeller 24 receives an aeration medium such as air through an annular clearance space 71 defined between the drive shaft 32 and a surrounding pipe 56, such that the downward circulation of fluid induced by the primary axial flow impeller in the central region of the tank wraps around the outwardly directly discharge of bubbles from the radial flow impeller. This purports to enhance contact between the aeration medium and the ore particles in the contact zone 48. From there, bubbles with mineral particles attached float through a perforated plate 52 into a quiescent zone 50.

In the apparatus of the present invention, the auxiliary agitation blade is adapted to induce *axial* fluid flow in a downward direction near the central axis of the tank so as to supplement the primary and secondary flows induced in the tank by the primary rotor. This axial flow of slurry contains virtually no air bubbles. By contrast, in D1, the secondary impeller is specifically designed to induce a *radial* flow that intersects with the downward axial flow induced by the primary impeller near the central axis of the tank, and is infused with air bubbles. Thus, the physical structures, modes of operation and intended functions of the respective devices are fundamentally different.

Citation D2 (AU199924989 to Yigit) discloses a flotation cell incorporating a primary stirring impeller 5 and a separating propeller 7 that are driven at different speeds by separate motors 3 through discrete belt drive mechanisms 8. A mixing chamber associated with the impeller 5 is segregated from a separation chamber associated with the separating propeller 7 by means of intermediate grates 10. The purpose of these grates is to divide the cell into two separate compartments and in effect to minimise the downward axial flow by the separating propeller. Rather, the specification emphasises the role of the separating propeller in creating centrifugal forces.

In the apparatus of the present invention, as noted above, the auxiliary agitator is specifically designed to induce a downward axial flow near the central axis of the tank which interacts in a complementary way with the flows induced by the primary rotor. There is no radial (ie centrifugal) component. Furthermore, in the present invention, the auxiliary agitator and the primary rotor are effectively conjoined for rotation at the same speed, by virtue of their attachment to the same drive shaft. In contrast to Citation D1, because the present invention requires only a single motor, a single drive mechanism, a single drive shaft and no intermediate grates, it would be significantly less complex and less expensive to manufacture, operate and maintain.

On this basis, there are significant differences between the invention as defined in the revised claims and the disclosure in each of the citations. These differences would not have been obvious at the priority date, and confer significant practical and commercial advantages over the prior art. We therefore request the establishment of a favourable report.

Yours respectfully
Shelston IP

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Encl.

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Contact: Stuart Smith

Attention: David K Bell

Dear Sirs

Patent Co-Operation Treaty Patent Application No.
PCT/AU2004/000315
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Title: AUXILIARY AGITATOR FOR A FLOTATION DEVICE

We refer to the Second Written Opinion of the International Preliminary Examining Authority mailed on 21 February, 2005 in respect of the above application.

Pursuant to Article 34, the Applicant requests the International Preliminary Examining Authority to take into account the amendments on the enclosed replacement pages, as set out in the attached Statement of Amendments. A marked-up copy indicating the nature and location of the amendments is also enclosed.

The independent claims 1 and 21, and the corresponding statements of invention within the body of the specification, have been amended to specify that the primary rotor is "...*adapted to induce radial flow...*". The independent claims further specify that the auxiliary agitation blade is "...*disposed above the primary rotor* and adapted, in use, to induce axial fluid flow in a downward direction so as to supplement flow induced in the tank by the primary rotor".

There is a complementary and synergistic interaction between the primary rotor which induces radial flow near the bottom of the tank, and the auxiliary rotor which is disposed above the primary rotor to induce axial flow in a downward direction toward the primary rotor. More specifically, the axial flow from the auxiliary rotor supplements the radial flow induced by the primary rotor, such that the two rotors in combination produce the desired circulation of slurry within the tank, as indicated by the arrows F1 and F2 in Figure 4. This circulation maintains the slurry particles in suspension and ensures optimum interaction with the dispersed bubbles from the aeration system, to produce the mineral enriched surface froth necessary for efficient mineral separation by flotation.

By contrast, citation D1 (US 6,109,449), and in particular the embodiment of figure 11, discloses two rotors 110 and 120, each of which quite clearly induces axial flow only. More specifically, even if these two rotors could be regarded respectively as primary and auxiliary agitators in the context of the present invention, the lower rotor, which would correspond to the primary rotor, does not induce radial flow.

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On this basis, it is respectfully submitted that the invention as now claimed is patentably distinguishable from the cited prior art, and we would therefore be grateful if the IPEA would establish a clear report.

Yours respectfully
Shelston IP

S.M.Smith

Encl.